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Forest Pest Management
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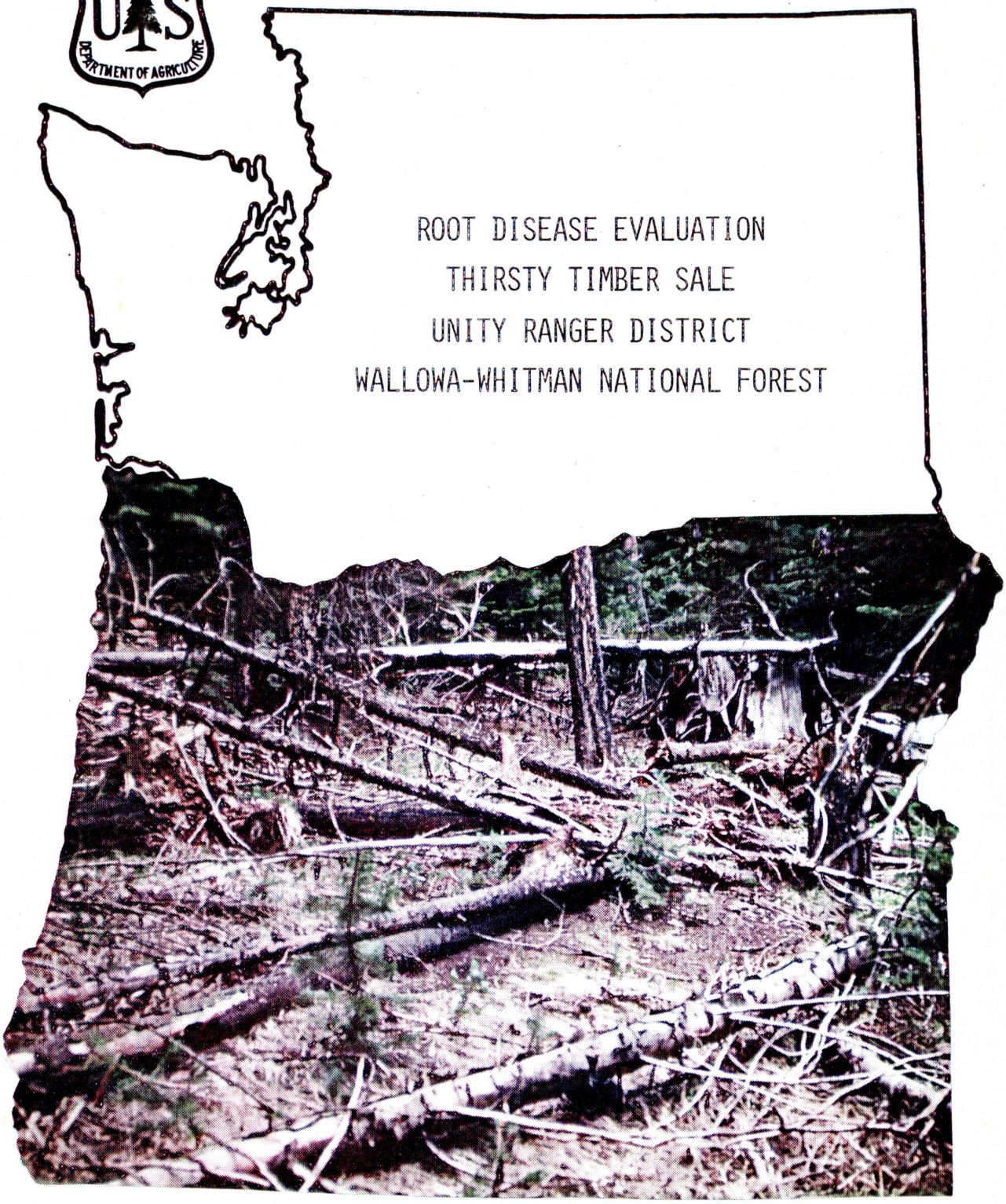

ROOT DISEASE EVALUATION
THIRSTY TIMBER SALE
UNITY RANGER DISTRICT
WALLOWA-WHITMAN NATIONAL FOREST

September 1982

ROOT DISEASE SURVEY OF THE THIRSTY TIMBER SALE UNITY RANGER DISTRICT, WALLOWA-WHITMAN NATIONAL FOREST

by

Craig L. Schmitt and Alan Kanaskie
USDA Forest Service
Pacific Northwest Region
Forest Pest Management
Portland, Oregon

INTRODUCTION

During the week of June 7, 1982, Forest Pest Management personnel did a disease survey of areas within the proposed Thirsty Timber Sale. Approximately 200 acres were surveyed within T. 13 S., R. 35½ E., sec. 10, 11 and 13 (Figures 1 and 2). The purpose of the survey was to identify the location of root disease centers and the specific pathogens involved. From this information, along with observations of stand and site conditions, tree species mix, and other disease problems present, disease management recommendations were developed.

The stands within the sale area include a mixture of lodgepole pine (*Pinus contorta*), grand fir (*Abies grandis*), ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*) and western larch (*Larix occidentalis*). Some stands had been partial cut in the past; mainly a selection system in which ponderosa pine was preferred. A few stands within the area originated following the "Big Cow Burn" of 1939, yet all age classes are represented throughout the remaining stands.

Five separate units were examined. These stands were identified by District personnel as having the highest suspected incidence of root rots. Root rot occurrence is suspected to some degree in other similar stands in the sale area.

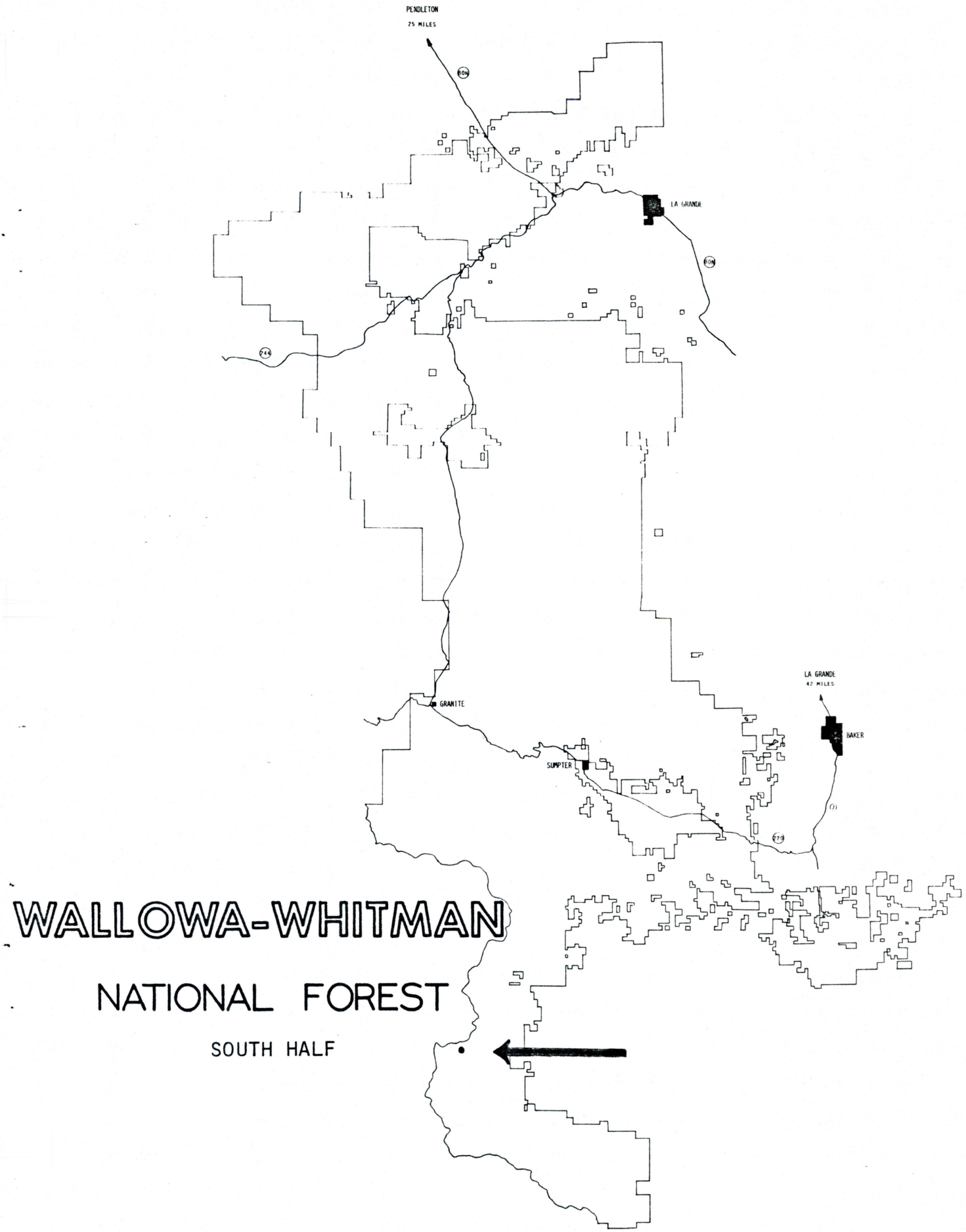

Figure 1. Map depicting location of the Thirsty Timber Sale area. (arrow)

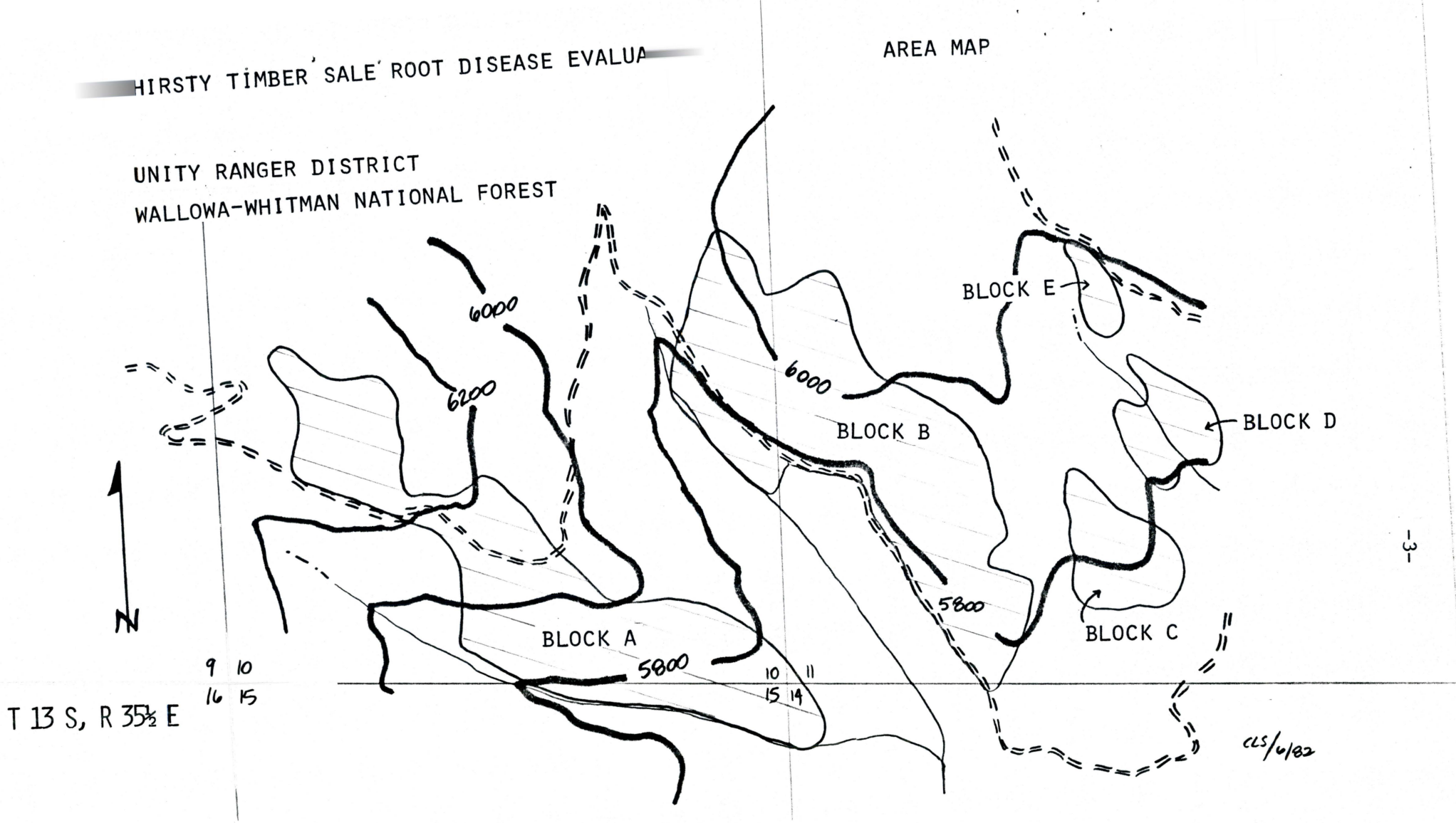

Figure 2. Map depicting location of surveyed blocks within the Thirsty Timber Sale area.

METHODS

A systematic survey was done by running transects at 4-chain (264') intervals across each sample block. Surveyors traveling the transects looked for diseased trees or centers within two chains of either side. Location along line, distance (from line), center size, and root pathogens were recorded.

Root disease information was used to construct stand maps indicating location of disease centers. Other insect, disease and stand information was noted and used to develop general management recommendations.

Root disease symptoms on infected living trees include: chlorotic and/or thinning foliage, an abnormal "distress" cone crop, recent reduced height growth, and resin flow at the base of the bole. Mortality usually occurs after the trees have been infected for several years. Since most root diseases spread via root-to-root contacts, slowly enlarging centers or pockets of mortality occur, with older dead trees in the middle, and recently-killed or live symptomatic trees around the perimeter.

Armillaria root rot, caused by the fungus *Armillaria mellea*, can be identified on a severely infected tree by removing a section of bark on a main root or at the root collar and exposing the cream-white colored mycelial fans (Plate 1). These can also be found on trees which have been dead less than 2 to 3 years. Trees killed by *A. mellea* usually remain standing for 2 to 3 years before they fall (Plate 2). Wood decay is spongy-yellow with characteristic black zone lines. Black rhizomorphs, infective string-like strands, are sometimes found under the bark or along the exterior of roots.

Annosus root rot, caused by the fungus *Fomes annosus*, can be diagnosed on dead trees by observing its characteristic irregular pattern of red incipient decay or the white-stringy advanced decay which contains large black specks. Fruiting bodies, although seldom found on dead trees, are common in old true fir stumps associated with *F. annosus*-caused mortality.

RESULTS

Maps indicating location and type of root disease are presented in Figures 3, 4 and 5.

Block A

This stand was composed of mature-overmature lodgepole pine, all age classes of grand fir, old growth ponderosa pine with some immature stems, overmature western larch, and mostly-mature Douglas-fir. Slopes are generally gentle on the ridges grading to 50-60% toward the creek bottom. Exposure is generally south. Some light partial cutting has taken place in the past, mainly salvaging and "high-grading."

Armillaria root rot-caused mortality was prevalent in the southern portion of this stand. A minor amount of annosus root rot was also found. Root diseases were found most frequently on grand fir and ponderosa pine. Lodgepole pine and western larch appeared to be the least susceptible to root rots. *A. mellea* appeared to have caused mortality in this stand for many years.

Plate 1. Mycelial fans on grand fir, characteristic of *Armillaria mellea*

Plate 2. An Armillaria root rot center

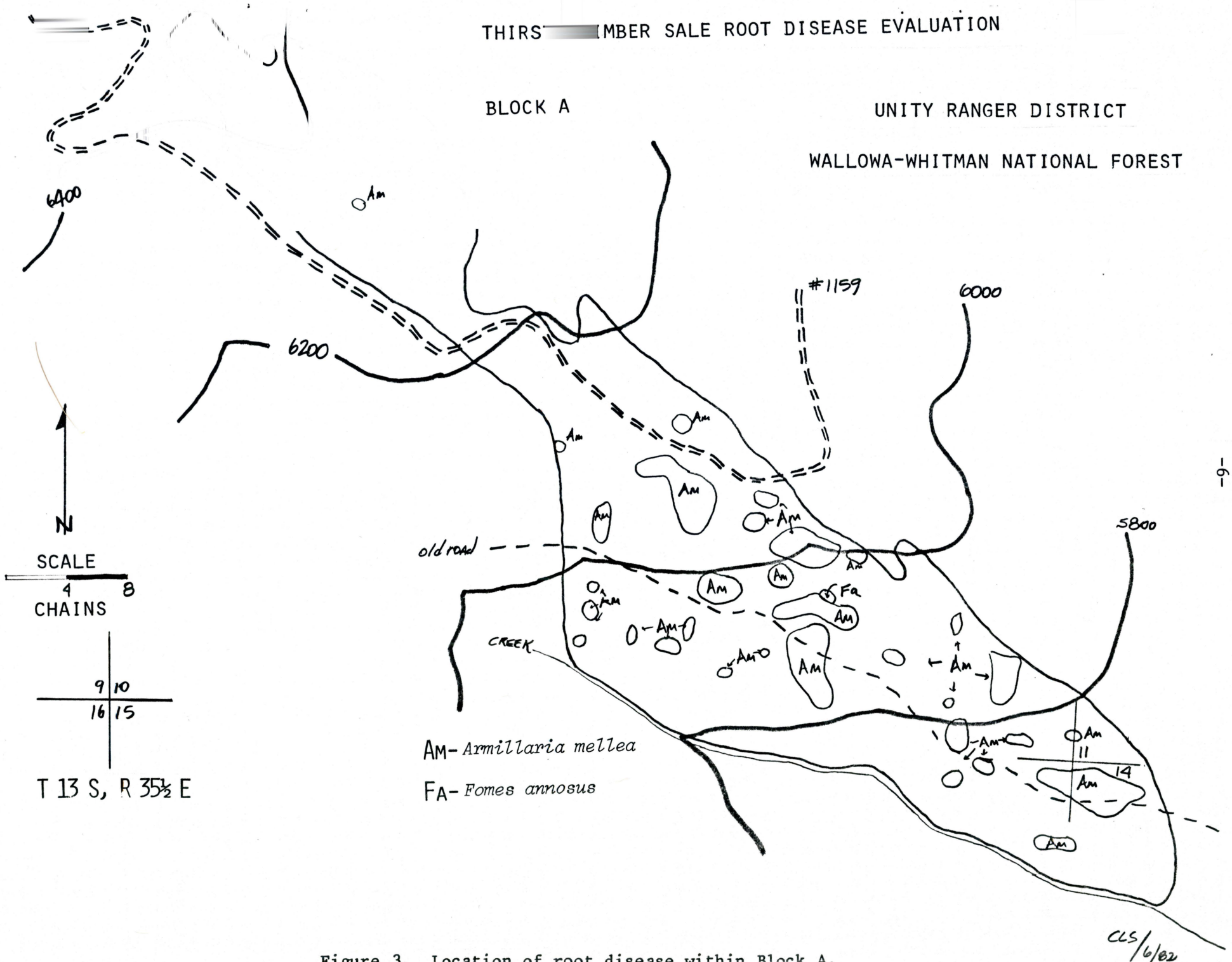

Figure 3. Location of root disease within Block A.

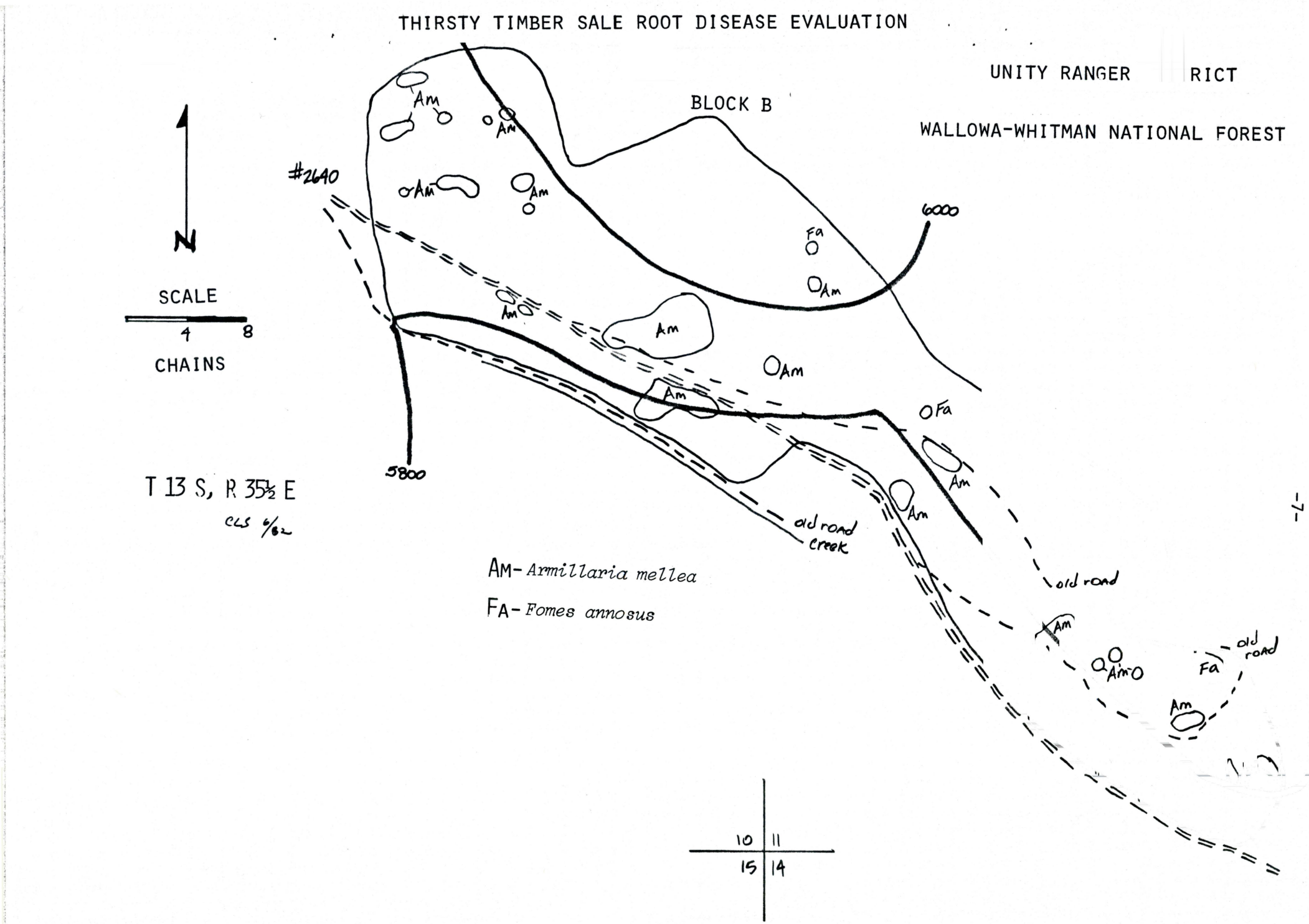

Figure 4. Location of root disease within Block B.

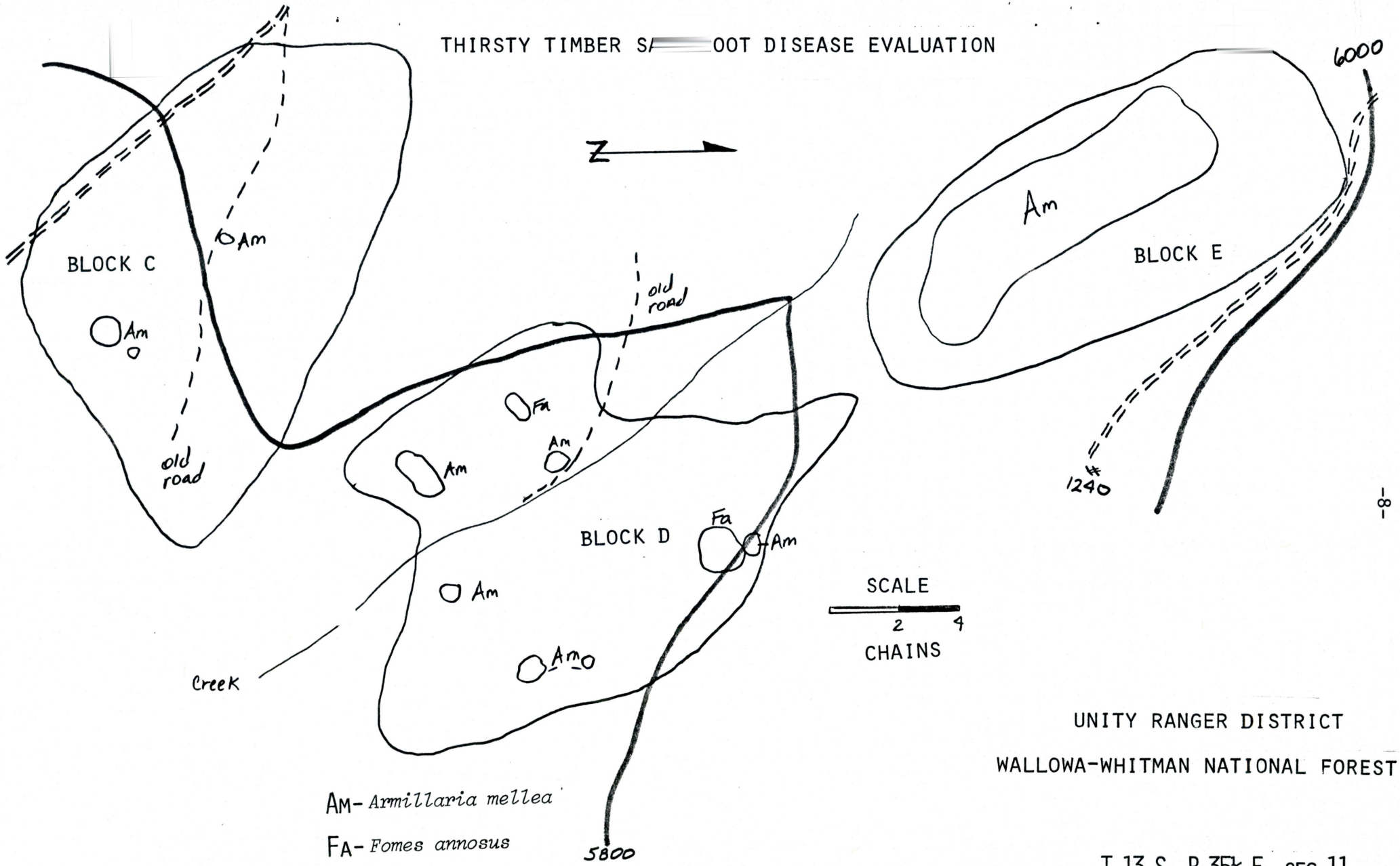

Figure 5. Location of root disease within Blocks C, D and E.

In addition to root diseases, other pests had caused considerable mortality throughout this stand. The overstory grand fir is heavily infected with Indian paint fungus, *Echinodontium tinctorium*. This stand component has been dying due to breakage of decayed stems, resulting in stand openings. These are being regenerated primarily with grand fir, most of which has not been suppressed.

Dwarf mistletoe-caused damage and mortality is very prevalent in larch and Douglas-fir. Few healthy large trees of these species were seen. Ponderosa pine and lodgepole pine are also being attacked by dwarf mistletoes. Growth loss, degrade and predisposition to bark beetles are the most significant dwarf mistletoe effects on ponderosa pine.

Most of the mature-overmature lodgepole pine has been killed by mountain pine beetle within the last 8 years. This was largely due to overmaturity and overstocking, along with the epidemic population buildup of beetles throughout the Blue Mountains.

Block B

This stand is similar in structure and age classes to that described in Block A, except there is little or no larch and a greater component of Douglas-fir and ponderosa pine. This is because of the slightly drier site due to a generally southwest exposure. Slopes are gentle on the ridges and 35-45% on the faces. A similar partial cut pattern is present as found in Block A.

Armillaria root rot is present throughout most of this survey block. Annosus root rot is also present to a lesser degree. As in Block A, grand fir and ponderosa pine are most heavily infected with root rots; lodgepole pine is affected the least. Mortality is occurring in ponderosa pine, largely attributed to *A. mellea* and western pine beetle, *D. brevicomis*.

A high level of mortality has occurred in the Douglas-fir due to dwarf mistletoe. Ponderosa pine is also infected with dwarf mistletoe, heavily in some areas.

Lodgepole pine had been a major stand component, yet was largely wiped out by mountain pine beetle. Similar stand conditions existed in Block B as they did in Block A.

The grand fir stand component is similar to that in Block A. Indian paint fungus is severe in the overstory trees, yet the understory is probably relatively healthy.

Blocks C, D and E

These blocks are relatively close to each other and have similar stand and age structures. Aspects are south to southwest facing except for a portion of Block D which faces east. As in the other areas, some partial cutting has occurred in portions of all blocks.

Grand fir is the predominant stand component with all age classes being present. Lodgepole pine makes up another significant stand component. Most larger trees have been killed by mountain pine beetle. The remaining lodgepoles are almost all seedlings, saplings and poles. Scattered overstory ponderosa pines are present along with sapling-size regeneration. A minor amount of larch and Douglas-fir is present. Most of these are sapling to pole-size.

Insects and diseases have caused heavy losses in these areas. Armillaria root rot was found in all blocks (Figure 5). As in the other areas surveyed, lodgepole pine appeared to be least susceptible to this disease. A large root disease center was found in Block E.

Annosus root rot was killing grand fir in two centers within Block D. This root rot was occurring in sparsely stocked areas. Grand fir appeared to be the only species affected.

Indian paint fungus-caused heart rot was present in most of the larger overstory grand fir. As in most stands throughout this area, heart rot has caused the overstory to break up, creating openings stocked with advanced regeneration.

DISCUSSION

Most conifers are susceptible to some degree to Armillaria root rot. Oftentimes the degree of susceptibility to infection in one area will differ from what occurs in another area.

Annosus root rot has been found to be a serious problem in many East Side partially cut true fir (*Abies* spp.) stands. This pathogen causes decline and mortality usually associated with old true fir stumps. Infected trees will usually display crown symptoms including thinning foliage and reduced height growth. Mortality occurs several years after infection, more rapidly with smaller trees. Recently-killed trees will display red to red-yellow foliage. Mortality is often associated with the fir engraver beetle, *Scolytus ventralis*, which will attack trees weakened by root rot.

Root diseases are most often found and most damaging where they affect groups of trees. Annosus root rot and Armillaria root rot pockets are usually centered around an old infected stump, dead tree or stub which can harbor the fungi in the root system for up to 50 years. The pathogens will spread from this material to susceptible regeneration upon root contact. Disease can then spread from tree to tree, expanding the center.

Dwarf mistletoes (*Arceuthobium* spp.) are plant parasites which are serious pests of conifers in some areas. There are a number of species, all are rather host-specific, most causing significant damage to only one or two host species.

Dwarf mistletoes harm their host by drawing on the tree's photosynthate and water reserves, thus lowering its vigor and growth. Abnormal branch formations are produced by the tree in response to dwarf mistletoe infection. These include "witches'-brooms" and abnormally large branches. These lower a tree's grade and reduce its value. Following years of infection, the parasite builds up on the host. Vigor is then reduced to the point where trees die outright or are attacked by other pests causing mortality.

Dwarf mistletoes spread within and between hosts during the late summer and fall via seeds shot from explosive capsules which fall from the female plant. Seeds landing on a host needle or leaf may start new infections.

Dwarf mistletoe control requires removing all infected hosts from a site and regenerating that host, or phasing out the host species while regenerating with a nonhost. Oftentimes a seed tree or shelterwood regeneration cut can be used, using a dwarf mistletoe-infected overstory seed source if that overstory is removed within 10 years following establishment of the regeneration.

Douglas-fir dwarf mistletoe (*Arceuthobium douglasii*) is found primarily on its principal host, Douglas-fir, and infrequently on grand fir. Management considerations need only deal with its principal host. When heavily infected, Douglas-fir is subject to reduction in grade, growth loss, pest attack and mortality.

Larch dwarf mistletoe (*Arceuthobium laricis*) is principally found on western larch with minor hosts including lodgepole and ponderosa pine. Only its occurrence on larch need be considered for management purposes. Dwarf mistletoe is quite common on larch and, where stands are infested, older individual trees are usually heavily infected. Larch trees heavily infected with dwarf mistletoe are very susceptible to mortality, usually directly, but sometimes in conjunction with other pests.

Western dwarf mistletoe (*Arceuthobium campylopodum*) is usually found on its principal host, ponderosa pine. Occasionally lodgepole pine will become infected with this species of dwarf mistletoe. In mixed conifer stands, infected ponderosa pine suffers growth reduction and value degrade due to formation of large, persistent branches. Mortality is usually associated with western pine beetle (*Dendroctonus brevicomis*) attacks on older weakened trees.

Brown stringy rot, caused by the Indian paint fungus (*Echinodontium tinctorium*) is a serious heart rot of true firs. This disease seems to be associated with older trees which had been suppressed (for at least 50 years) by an infected overstory, and sometime in its recent history been scarred.

This fungus apparently enters trees through tiny branch traces. These may become enclosed in the bole as the tree grows radially. When this growth is slow, as when the tree is suppressed, infection may be introduced and remain dormant. While infection is present, heart rot usually does not occur unless the tree is scarred, in which case the fungus is activated and decay begins. Since most mixed conifer stands are managed with frequent entries, a high incidence of scarring can result.

Current recommendations call for managing releasable advance true fir regeneration on short rotations of less than 150 years to minimize extent of decay. Calculator programs are available through Forest Pest Management to predict the (1) current percent of Indian paint fungus infection, (2) current amount of decay, and (3) future decay volumes in stands of advanced white or grand fir regeneration.

The mountain pine beetle (*Dendroctonus ponderosae*) is an extremely destructive pest of lodgepole pine (Plate 3). This bark beetle prefers mature forests or younger, overstocked stands. Outbreaks occur when stand and environmental conditions are favorable, allowing an epidemic population of insects to build up. Mortality can be very extensive with most trees larger than 4 inches in diameter killed over a wide area.

MANAGEMENT ALTERNATIVES

There are varying levels of root diseases, heart rot and dwarf mistletoes throughout the timber type in the surveyed area. Future treatment strategies should strongly involve pest management. General alternatives will be presented, followed by specific pest management recommendations:

Plate 3. Lodgepole pine mortality caused by the mountain pine beetle

1. Harsh site conditions would make it difficult to regenerate units if large clearcuts were used. A system of partial cutting with group selections (using small clearcuts or overstory removal) may be beneficial.

2. Armillaria root rot is a serious disease problem in the areas surveyed. There are two basic disease management options available for lessening losses caused by Armillaria root rot in mature East Side mixed-conifer stands. These include clearcutting trees in infected centers including a 50' buffer strip and (a) removing infected stumps and root systems from the soil using heavy equipment and regenerating the site with susceptible, although preferred host species; or (b) restocking the centers and buffers with species least susceptible to Armillaria root rot. There seems to be some variability in species susceptibility in different areas on the East Side, probably reflecting differences in the strain of the fungus. Species susceptibility in the Thirsty Sale area in decreasing order is (1) grand fir, (2) ponderosa pine, (3) Douglas-fir, (4) western larch, (5) lodgepole pine. Of these, only lodgepole pine and western larch are low enough in susceptibility to consider their use in restocking centers without removing the stumps and root systems.

In the Thirsty Sale area, species conversion within centers is a more viable alternative than stump removal. Removing the infective material from the soil is expensive, difficult on steep ground, and may cause soil damage if improperly done. The process will be further hampered by rocky soils. In addition, the extensiveness of Armillaria root rot in the survey blocks and probably in other stands in this area make this option less preferable than species conversion.

3. The overstory grand fir is almost all overmature and largely infected with Indian paint fungus and root rots. Severely suppressed true fir understories are susceptible to infection by Indian paint fungus. Suppression of the true fir understory did not appear to be a problem because most of it had regenerated following the breaking up of the overstory.

4. Dwarf mistletoes have caused extensive damage throughout this area. The all-aged stand structure is conducive to dwarf mistletoe buildup and their perpetuation through time. Larch and Douglas-fir are most seriously affected by these pests. Ponderosa pine is infected in some areas, but damage is considerably less than that suffered by the two other species. Fortunately in this area these dwarf mistletoes are relatively host specific.

Dwarf mistletoe management alternatives include: (a) salvage heavily infected trees during any stand entry, (b) prevent the spread of dwarf mistletoes from infected overstory to healthy understory of the same species by removing the larger trees as soon as possible. If a regenerative partial cut silvicultural system is used, the overwood should be removed before the understory is 3 feet tall, (c) conversion of the portions of the stand to species not being affected by dwarf mistletoes. Generally, this involves favoring or artificially regenerating a nonhost species in a stand where the source of the infection cannot be removed. (d) if a precommercial thinning is scheduled, discriminating against dwarf mistletoe-infected trees should be a dominant guideline.

5. Annosus root rot is present in the area but was encountered infrequently during the survey. Grand fir was the only species observed being affected. Management recommendations for annosus root rot are similar to those for Armillaria root rot. The difference is that Douglas-fir and ponderosa pine could be used along with larch and lodgepole pine in restocking or species conversion.

6. Bark beetles have caused extensive damage in these stands. The mountain pine beetle has essentially wiped out the overstory lodgepole pine component. Some smaller ponderosa pine have been attacked by this insect. This insect is able to cause the most damage in older, overstocked lodgepole stands and overstocked ponderosa pine stands. Management is a matter of maintaining stand vigor. Intermediate thinning(s) should be done to maintain adequate spacing and thus vigor. Rotation ages of 80 years will also eliminate much of the hazard in lodgepole pine stands.

The western pine beetle was found to have killed occasional older ponderosa pine in the area. Generally, endemic populations of this pest occur throughout the pine type, breeding in diseased, overmature and windthrown trees. Management activities to minimize losses should include salvaging attacked and dying trees and not managing stands beyond maturity.

MANAGEMENT RECOMMENDATIONS

1. When and where possible, management actions should minimize conversion of these stands to predominantly grand fir.

2. Root rot centers should be treated in the upcoming stand entry. The remaining host overstory should be removed including 50' buffer strip. Do not cut healthy lodgepole pine or larch which may be in these centers. Small lodgepole and larch regeneration should also be retained to provide shading and assure stocking on the site. Any slash disposal and site preparation techniques used should be chosen after evaluating stocking levels of desirable advance regeneration and leave trees. Plant these areas with lodgepole pine or a mixture of lodgepole pine-western larch where it is suited. Following the sale, remaining grand fir should be thinned from the centers and buffers.

3. Where healthy larch exists or will be planted, dwarf mistletoe-infected overstory larch within 40 feet should be harvested.

4. Overstory grand fir should be removed in the timber sale. This will remove a large source of *E. tinctorium* inoculum. Grand fir advance regeneration is generally healthy and could be used where root rots are absent. Indian paint fungus infection hazard should be low if these smaller trees are not allowed to stagnate in growth.

5. In areas free of roots rot where young grand fir stocking is heavy, a precommercial thinning following the sale may be desirable. If other species are intermixed, they should be preferred crop trees.

6. Areas infected with dwarf mistletoes but free of root rot should be treated in the following manner:

a. Remove heavily infected trees and any infected overstory which is overtopping an understory of that species. Following the sale, schedule a precommercial thinning in those stands to improve spacing. Preference for crop trees should be those with no dwarf mistletoe or those with infections only in the lower crowns.

b. Species such as ponderosa pine, Douglas-fir, western larch and possibly lodgepole pine should regenerate following a shelterwood cut. Preferred leave trees should be of these species, have minimal infections, and show promise of producing cones. Following the harvest and site preparation, regeneration should be monitored and the overstory removed as soon as full stocking can be assured. Little or no dwarf mistletoe infection should be expected if the overstory is removed before the regeneration exceeds 3 foot tall, and any which does occur can be removed during a thinning.

Prepared by: Craig L. Schmitt Date 9/23/82
CRAIG L. SCHMITT, Plant Pathologist

Prepared by: Alan Kanaskie Date 9/23/82
ALAN KANASKIE, Biological Technician

Reviewed by: James S. Hadfield Date 9/24/82
JAMES S. HADFIELD, Supervisory Pathologist

Approved by: Randall E. Silvius, for Date 9/27/82
PAUL E. BUFFAM, Director, FPM